VANM256.001AUS PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Nicholas Cerf, et al.
Appl. No.	:	10/615,490
Filed	:	July 7, 2003
For	:	HIGH-RATE QUANTUM KEY DISTRIBUTION SCHEME RELYING ON CONTINUOUSLY PHASE AND AMPLITUDE-MODULATED COHERENT LIGHT PULSES
Examiner	:	Jaric E. Loving
Group Art Unit	:	2137

DECLARATION UNDER 37 C.F.R. § 132 TO OVERCOME NAMBU

1. This Declaration is to traverse the rejection of the claims in the above-captioned U.S. patent application by U.S. Patent No. 6,801,626, entitled CRYPTOGRAPHIC KEY DISTRIBUTION USING LIGHT PULSES OF THREE MACROSCOPIC QUANTUM STATES, to Nambu, which was cited by the Examiner against the above-captioned application.

2. I, Gerd Leuchs, am a professor of physics at the University of Erlangen-Nürnberg, Germany. I studied physics and mathematics at the University of Cologne, Germany, and received my Ph.D. at the Ludwig-Maximilian-University of Munich, Germany in 1978. I also made two research visits at the University of Colorado in Boulder, Colorado, and later became technical director at Nanomach AG in Switzerland. Since 1994, I have been holding the chair for optics at the Friedrich-Alexander-University of Erlangen-Nürnberg, Germany. My fields of research span the range from modern aspects of classical optics to quantum optics and quantum information. Since 2003, I have been Director of the Max Planck Research Group for Optics, Information and Photonics at Erlangen. Since 2004, I am a fellow of the Optical Society of America and between 1996 and 2005, I was a member of the board of the Quantum Electronics and Optics Division of the European Physical Society. I am the co-editor of two recent books, *Quantum Information Processing* and *Lectures on Quantum Information*. I am not an inventor of the claimed invention, and do not have an interest in the outcome of this application.

3. I have read the above-referenced patent application, U.S. Patent No. 6,801,626 by Nambu, the amended claims and the Office Action mailed September 8, 2006 regarding the patent application.

4. In my opinion, the Nambu reference does not anticipate the amended claims of the application for at least the following reasons:

a. The Office Action contends that Nambu discloses continuous phase and amplitude modulation. The Examiner asserts that in Nambu's patent, "[t]he change in bit is significant enough to create a change in amplitude of the signal". The alleged "change in bit" as formulated by the Examiner has nothing to do with the modulation, but rather refers to a data stream, consisting of bits, that will be encoded into a signal by the technique of phase modulation. Nambu adopts a scheme that uses a discrete (actually, binary) modulation, where the values 0 and 1 of the bit translate into the phase shifts 0° and 180° respectively (Nambu, column 3, lines 44-46). In contrast, in the present application, the phase is modulated continuously from 0° to 360°. This is not a straightforward extension of the scheme of Nambu. In Nambu, a "0" bit is encoded by inferring a 0 degree phase shift to the signal and a "1" bit is encoded by inferring a 180 degree phase shift. As there do not exist other bits than "0" and "1", it results that the only possible phase shifts that are modulated into the encoded signal in Nambu are 0 and 180 degrees. As a result of this, the detector that is meant for detecting the phase shifts will only look at 0 and 180 degree phase shifts. Therefore, the modulation of Nambu is a discrete phase modulation (Nambu, column 7, lines 24-28), which is in contrast to the continuous modulation as recited in Claim 1 ("continuously modulated in phase and amplitude") and similarly in amended Claims 17 and 20, and in Claim 27 of the present application.

b. An amplitude modulation is absent in the scheme of Nambu. Nambu does not disclose that the change of bits of the data that will be encoded creates an amplitude change of the signal. Furthermore, even if the amplitude of the encoded signal should change, Nambu does not disclose that the change in amplitude is caused by amplitude modulation of the data that is encoded. Therefore, the system of Nambu does not disclose the use of amplitude modulation as recited in Claim 1 ("continuously modulated in phase and amplitude") and similarly in amended Claims 17 and 20, and in Claim 27 of the present application.

c. The security analysis of the application uses Gaussian-modulated coherent states as recited in Claims 9 and 10. Shannon's information theory for Gaussian channels makes it possible to estimate the maximum amount of information a potential eavesdropper may gain as recited in Claim 13. Hence, an "all-continuous" strategy is used in the present system in which the encoding (Gaussian modulation) and decoding (homodyne detection) both involve real numbers and not binary digits (bits) as disclosed in Nambu. The section of Nambu at column 10, lines 18-33 concerns the probability distribution that is observed when measuring the quadrature components (a_1 , a_2) of a coherent state. In Nambu, the center of this distribution is located in either in (1, 0) or in (-1, 0), which translates the binary character of the modulation (see Figure 4 of Nambu) depending on whether the phase modulation carries out a 0° or 180° phase shift. As recited in Claim 10, the coordinate values of the center of the Gaussian distribution are arbitrary.

d. The term "continuous" can refer to a real number being encoded (see for example, Claim 14 where "random numbers x_A and p_A" are recited) into a corresponding phase shift and amplitude. The phase shift and amplitude can thus attain any value within a chosen range, and therefore, the modulation can be continuous (see page 16, 3rd last line to page 17, 2nd line of the patent specification). The Nambu reference only discloses the encoding of the discrete (binary) values of zero and one. New Claim 30 recites that numbers from a continuous distribution are encoded into corresponding phase shifts and amplitude. The Nambu reference does not disclose that numbers from a continuous distribution are encoded into corresponding phase shifts and amplitude.

e. Claim 17 recites in part: "an optical component configured to modulate the amplitude and phase of the pulses at a high frequency". In contrast, Nambu only discloses a phase modulator. There is no mention of an amplitude modulator in Nambu's document.

f. Claim 20 recites in part: "an integrated electro-optic amplitude modulator and a piezoelectric phase modulator, configured to...". The technical feature of the "amplitude modulator" in Claim 20 is not anticipated by Nambu, because Nambu's disclosure only refers to a phase modulator.

g. New Claims 31-32 recite that the pulses are configured to represent a pair of numbers selected from a continuous distribution and that the quadrature component at the receiver is a number selected from a continuous distribution. The Nambu reference only discloses the encoding of the discrete (binary) values of zero and one.

5. Therefore, in view of the above and being one skilled in the technology, I submit that the Nambu reference does not disclose each and every feature of the amended claims submitted herewith.

6. This declaration is submitted with a Request for Continued Examination (RCE).

Penalty of Perjury Statement

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful, false statements may jeopardize the validity of the application or any patent resulting therefrom.

Dated: 27. February 2007 By: _____
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